A Hybrid Immersive / Non-Immersive Virtual Environment Workstation

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Introduction

In the design considerations of the Immersive portion of this system, it is important to keep the expected setting in mind. The expected setting is on board a ship or other Naval vessel. In such a situation, it is expected that the deck may well be rolling back and forth to some degree. Floor space is also a limited resource and the physical footprint of the system needs to be relatively small. In addition, the systems must integrate with other equipment which is already there. Thus, systems which require a stable frame of reference, demand a large area, or a specialized room are less preferred.

Immersive Systems for Shipboard Use

The delivery of immersive experiences can be accomplished in several ways. The range of approaches for the delivery of these experiences is highly varied. A clearer understanding can be gained by broadly categorizing the various approaches currently in use. Many of these ideas have been generated and discussed between Mark Bolas and Steve Bryson over the last year.

Virtual reality emphasizes the concepts of immersion and presence. For the purpose of this discussion the following are used:

> *Immersion* is the sense of being surrounded by a synthetic environment.
>
> *Self-presence* is a sense of personal awareness and position relative to an environment.
>
> *Object-presence* is the sense that an object exists and is positioned relative to an observer and an environment.

- Immersion requires a display which provides images regardless of where the user may look and is quickly degraded by inappropriate sensory cues.
- Self-presence requires a representation of the user and can tolerate displays which do not completely surround the user.
- Object-presence requires high fidelity images and cues related to the object. It is significantly enhanced when interaction with the virtual object is possible.

The ideal virtual reality display system would support a strong sense of immersion, self-presence, and object-presence. Unfortunately, there is no currently available system that provides all three qualities equally well. As such, the following classification of virtual display systems is used to correspond with the concepts of immersion and presence as defined in this paper. All systems are assumed to be stereoscopic and provide head-tracked first-person point-of-view images.

<u>Head Mounted Displays</u> (HMDs) are those used to provide a feeling of immersion within a virtual space. They present head-tracked images which appear to completely surround the user. HMDs only require that the portion of the scene which is within the user's field-of-view be rendered by the system. These systems seem to be appropriate when a complete sense of immersion in the virtual environment is desired.

Spatially Immersive Displays (SIDs) typically surround a large subset of a user's periphery with large screens. They use head-tracking to render images with the appropriate motion parallax, but do not use head-tracking to render where the user is looking, as they must render multiple points of view to multiple screens which physically surround the user. These systems seem to be appropriate when a sense of self-presence within a virtual environment is desired.

Virtual Model Displays (VMDs) typically take the form of a desk, workbench or monitor. They use head-tracking to render images with the appropriate motion parallax onto an imaging surface, such as a table-top or a window. These systems seem to be appropriate when a sense of object-presence is desired, for example, creating a virtual model that appears to sit upon the surface of a workbench.

HMDs provide a strong sense of immersion due to their ability to display images regardless of where the user is looking, however they can have poor self and object-presence due to low fidelity displays and the occlusion of real-world cues. SIDs have a strong sense of self-presence due to their wide field of view, image fidelity and non-occlusion of real-world cues. Unfortunately SIDs tend to provide a weaker sense of immersion as they usually do not completely surround the user. SIDs also have a poor sense of object-presence as their display surfaces are typically far from the user, so accommodation cues are incorrect for close objects. VMDs have a limited sense of immersion as they do not surround the user with a whole environment, but they can have a very strong sense of object-presence due to their image fidelity and also due to the match between accommodation and convergence between the screen and the virtual model.

We are aiming for an Immersive experience, therefore, using the above categories, suitable technologies include HMDs & SIDs. These systems both deliver an immersive experience to the user. They are both single user systems. While it is clear that HMDs are single user devices, it is less obvious that SIDs are primarily single user devices.

SIDs For Shipboard Use

The SIDs are typically projection based rooms, corners, or other projection based immersive spaces. They produce the immersive experience by drawing stereo images on each of the walls. These images are calculated to take into account the position and orientation of a single user whose head position and orientation are measured and reported to the computer. A user in a projection based room is tethered by an "umbilical" which links the user's head and hand trackers (and possibly the signal for controlling the shutter glasses) back to the computer. Most systems of this type support a single head tracked view.

These projection based rooms have substantial footprints and generally use magnetic tracking which is susceptible to interference from nearby metallic objects. In addition, the user is tethered to the system. These factors make such systems less than ideal for shipboard use.

HMDs for Shipboard Use

HMDs provide an immersive experience to a single user by placing small high resolution displays in close proximity to the user's eyes. The user looks at the displays through viewing optics which

magnify the image so the user sees a virtual image in front of each eye. When this technology is coupled with head tracking, the result is a virtual world in which you can look around.

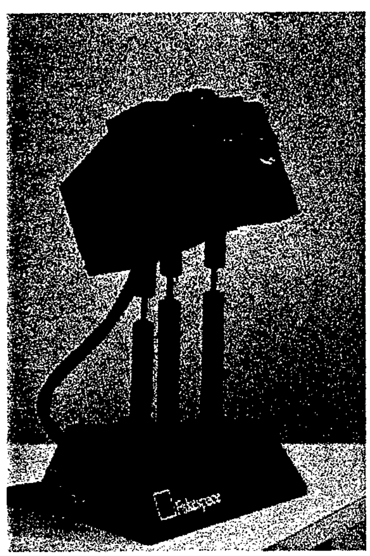
When looking at how this technology might be incorporated in a shipboard application, it is clear that several issues must be overcome. In particular, the user will have to wear the HMD and this will occlude the user's view of other things going on in the real world. This is difficult because face to face communication is very effective and when wearing an HMD, these communication skills are going to be impaired. The use of a see-through display might be possible but then activities in the virtual and real world have to compete for the user's attention. As with most traditional virtual reality approaches, this system requires that the user be tethered to the computer.

Therefore, while an HMD could be used, it will restrict the flexibility of the user and lock them into wearing a piece of tethered equipment. In a stable environment, this might be practical but on a moving / rolling ship this might be perilous to the user. However, there are some HMD derivatives which might be practical.

An HMD Derivative for Shipboard use

There are display systems which combine some of the immersive qualities of an HMD but do not require the user to be "strapped in". In addition, these approaches might provide some additional advantages which lead to a more consistent human-computer interface metaphor for both the Immersive and Non-Immersive components of the system.

The PUSH by Fakespace is a desktop immersive interface that is used at a desktop as shown below:



The Push provides a high resolution interface to a virtual world which you can look into. The navigation metaphor and tracking is built into the mechanical design in the base of the display unit. The two field sequential displays are viewed through optics which are interchangeable and thus support a variety of fields of view between 45 and approximately 120 degrees. For immersive applications, wider fields of view are generally preferred.

There are also Virtual Binoculars on the market from a company called Nvision. The Virtual Binoculars provide an interface for users to experience a virtual environment in a way to which they are already accustomed. The Virtual Binoculars are held by the user while the user looks around at a computer generated scene. The field of view of the Binoculars is about 40 degrees which is rather suboptimal for an immersive experience. The Binoculars are heavy (over two pounds), therefore holding them up for an extended period of time on a moving ship is probably impractical.

The Push and Virtual Binoculars both provide an immersive experience in a way that is potentially compatible with a shipboard environment. They will function well on a moving platform, do not attach anything to the user, and provide the desired immersive interface. The PUSH display has also two additional features which make it a preferred interface. Firstly, it is a desktop device and therefore does not have to be held up by the user, and secondly, it includes a built-in navigation paradigm.